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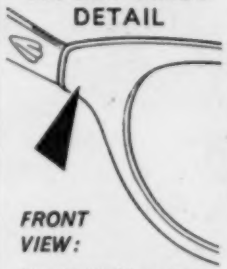

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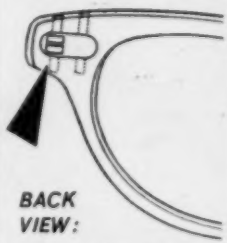

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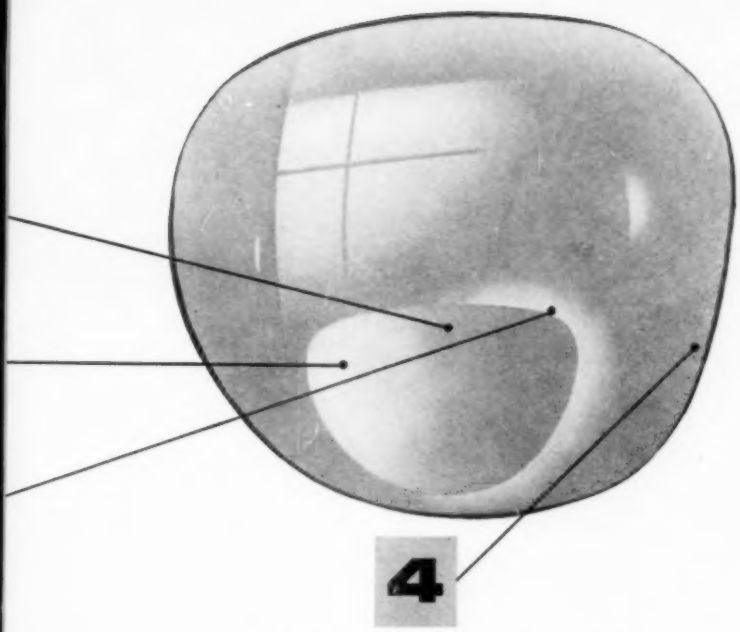

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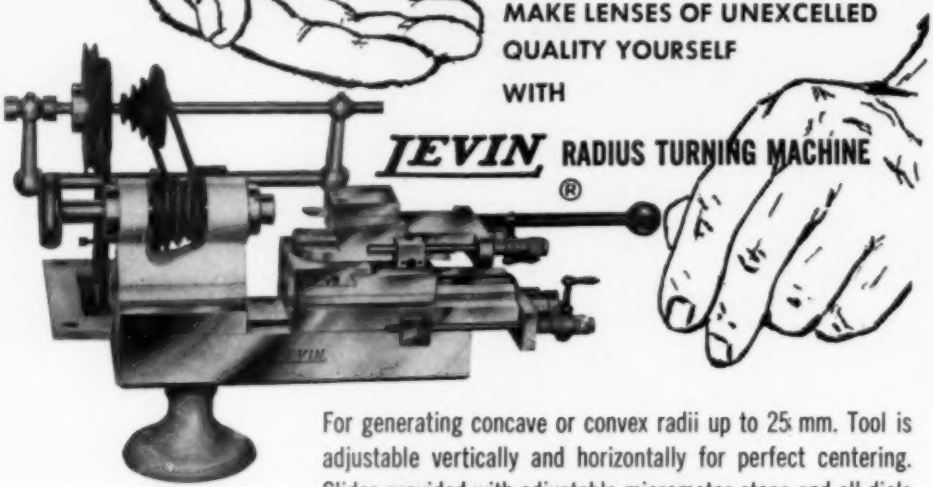

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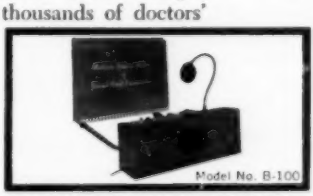

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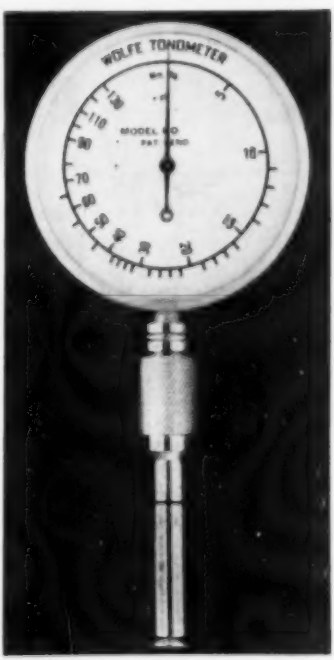

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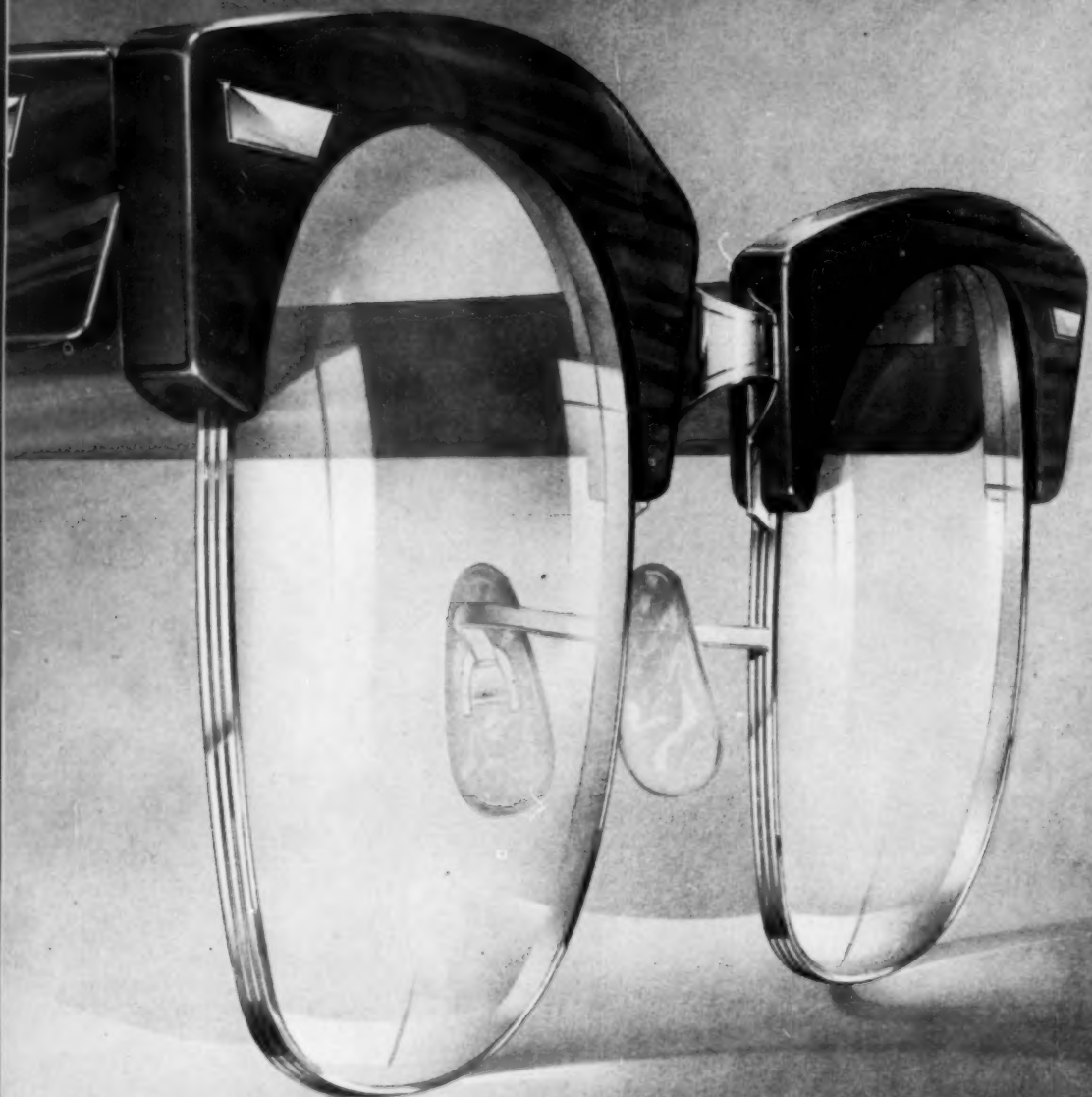

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Vol. 36 February, 1959 No. 2

THE EVOLUTION OF CORNEAL CONTACT LENSES*

Robert Graham†
Pasadena, California

Corneal lenses are the smallest, the least visible and in certain optical respects the finest of all devices for correcting faulty vision.** They have come to occupy a predominant place in the work of providing normal vision without spectacles. Their growing importance makes it appropriate to inquire into the origins and development of these very useful ophthalmic devices.

DA VINCI

So far as the known records reveal, Leonardo da Vinci was the first person to conceive of neutralizing the cornea and substituting for it a new refracting surface. About A. D. 1508, he described several forms of contact lenses which would accomplish this result.[1] Some of his devices were enormous and complex; some were tiny and simple. He did not describe corneal lenses but did suggest the principle upon which they, as well as scleral contact lenses, function. Accordingly, both types of contact lenses may be said to have had their inception with da Vinci. Figure 1.

DESCARTES

The first individual to place a lens directly upon the cornea, without scleral contact, was René Descartes. In 1636 he described and illustrated a contact lens as one of his "Ways of Perfecting vision."[2] Concerning his illustration, shown in Figure 2, he wrote:

> "If one applies directly against the eye a tube full of water, like E F, at the end of which there is a glass G H I, whose shape is exactly like that of the skin B C D, . . . there will no longer be any refraction at the entry of this eye."

The tube full of water must have required external support, instead of being self-supporting as present corneal lenses are. However, had Descartes shortened his column of water as much as possible—that is,

---

*Read at the Fifth International Congress of Contact Lens Specialists, Munich, Germany, 1958. Submitted on November 15, 1958, for publication in the February, 1959, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

†Optometrist. Associate Professor, Los Angeles College of Optometry. Special Lecturer in Physical Optics, College of Medical Evangelists, Los Angeles. Fellow, American Academy of Optometry and Diplomate, Contact Lens Section, American Academy of Optometry.

**Corneal lenses induce a minimum of aniseikonia in cases of anisometropia; they induce fewer prismatic effects than do spectacle or other contact lenses; with them the optical irregularities of corneas are most completely neutralized, resulting—in certain cases—in better visual acuity than is attainable with other corrective means.

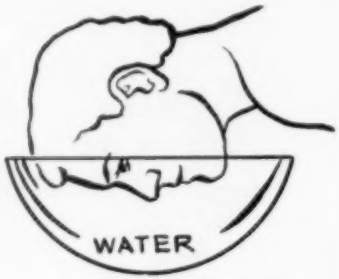


Fig. 1. A hollow glass semispheroid filled with water. One type of contact lens illustrated in da Vinci's Folio 7, V. Among other types suggested were "little round ampules" to be cut in two and filled with water, "if you want to look with only one eye."

until there was only a capillary layer of tear fluid left, thus eliminating the tube—and had he reduced his lens element to a small meniscus, shaped as he specifies, exactly like the cornea, he would have had a typical corneal lens. He actually had a grossly elongated corneal lens resting within the limbus of the eye. His proportions were poor, but his principle was quite correct. The evolution of corneal contact lenses, as distinct from sclerals, begins crudely but unmistakably with Descartes.*

HERSCHEL

Sir John F. W. Herschel wrote in 1827:[3]

"The strict method, applicable in all such cases (of irregular cornea), would be to adapt a lens to the eye, of nearly the same refractive power and having its surface next to the eye an exact intaglio facsimile of the irregular cornea, while the external should be exactly spherical of the same general convexity of the cornea itself: for it is clear, that all the distortions of the rays at the posterior surface of such a lens would be exactly counteracted by the equal and opposite distortions at the cornea itself.

"Should any very bad cases of irregular cornea be found, it is worthy of consideration, whether at least a temporary distinct vision could not be procured, by applying in contact with the surface of the eye some transparent animal jelly contained in a spherical capsule of glass: or whether an actual mold of the cornea might not be taken and impressed on some transparent medium."

There is nothing in Herschel's writings to show that he considered any contact other than corneal contact. For optical purposes, that is all that is necessary. Herschel has a place in the evolution of corneal lenses, not because he made corneals, or described them as such, but

*The following criteria serve to distinguish between scleral and corneal contact lenses: Scleral lenses always contact the sclera; corneal lenses always contact the cornea. Sclerals may also contact the cornea, but only secondarily. Similarly, corneals may contact the sclera, but only secondarily. Sclerals may employ fluid or be fluidless (that is, use no fluid other than tears). The same is true of corneals. (Descartes' is an example of a fluid corneal lens). Typical scleral contact lenses have a central optical zone, surrounded by a flattened zone or flange shaped to rest upon the sclera. Corneals may possess a peripheral bevel or flattening on the inside surface, but in them a true scleral flange is invariably absent.

Fig. 2. Corneal contact lens illustrated in Descartes' *La Dioptrique*, Discourse VII.

because his sound and widely circulated proposals pointed out that corneal lenses, as we know them today, were possible.

1888

The above concepts notwithstanding, the first contact lenses known to have been worn beneath the eyelids were not devised until 1888. The year was a momentous one in the history of visual correction. At that time two men, in different countries, and each unaware of the other, invented adhering lenses which could be worn in contact with the eyes. The ferment of circumstance, which so often brings new ideas into being simultaneously in different parts of the world, had generated a new way to correct defective vision in mankind.

FICK

Of the two men, A. Eugen Fick was the earlier, by a slight margin, to publish his results. In a remarkable treatise titled: "A Contact Spectacle,"[4] he described the first powered contact lenses known to have actually been worn. From his treatise we quote the passages which describe the lenses he used. A literal rather than a literary translation is employed so as to carry over into English his exact meanings. On page 280 of the journal in which his article appears is the following passage:

". . . it is certainly not superfluous to look for another means (than spectacles) to correct the different types of irregular astigmatism. The most radical means would obviously be to substitute for the cornea another regularly curved surface. This can really happen now, and I shall show in these papers that I have succeeded to exclude the faulty cornea from its total dioptrical powers with a very small glass bowl and to increase the minimum visual acuity of an eye from 1/30 to 1/6 without contraction of the visual field."

On the next page he writes:

"The contact spectacle consists of a thin, very small glass bowl bounded by concentric and parallel sphere segments."

A bowl bounded by *concentric* and parallel sphere segments can only have the simple form characteristic of corneal lenses. It could not have the scleral flange or compound construction found in scleral contacts. Figure 3 diagrams what Fick has here specified. When Fick later (his page 285) mentions scleral contacts, he describes them as quite different from the above lens.

$R_1 = R_2 + T$

WHERE R_1 = RADIUS OF OUTSIDE SURFACE
R_2 = " " INSIDE "
T = THICKNESS
C_1 & C_2 ARE THE CENTERS OF CURVATURE.
BY DEFINITION THEY COINCIDE.

Fig. 3. "A thin, very small glass bowl bounded by concentric and parallel sphere segments."

He continues:

"The same is placed on the eye, and the space between the little glass and the eyeball is filled with a liquid which has the same refractive index as the cornea. . . .

"I began my investigation to determine through animal experiments whether or not and for how long one may place a contact lens onto the eyeball without the same receiving damage. As experimental animals, large rabbits proved themselves preferentially suitable. From one of those animals, I lifted away the lids and nictitating membranes of the eyeball and filled the pocket so obtained with a paste of gypsum (plaster of Paris). After congelation has taken place, such a mold of the eyeball shows that the radius of curvature of the cornea does not differ essentially from that of the sclera and that the eyeball of the rabbit is a practically perfect sphere. Thereafter I had very small glass basins blown after these gypsum casts, whose shape became ever simpler, until finally after numerous trials, I abandoned the casts completely and was satisfied with preparing glass bubbles of 21, 20 and 19 mm. diameter and to break off a segment, the base of which had only a few mm. distance from the middle point of the sphere. From a great number of such very small bowls, I selected then for each individual rabbit the one most suitable."

Here it is unmistakably clear that many of the structures which Fick used in his early investigations were simple segments of hollow glass spheres. Fick states further (page 284):

"May we assume now that the human eye will react to the contact lens in the same manner as described above for the rabbit eye? The practical usability of the contact lens would then be beyond questioning! To prepare contact lenses that fit a human eye, I again made gypsum casts—naturally from cadaver eyes. The cast of a human eye shows very plainly that the cornea is a spherical segment with a smaller radius of curvature than the rest of the eyeball. . . . I had first of all a glass bubble prepared which fitted the periphery of the gypsum cast; then one spot of the glass bubble was heated anew and a protrusion blown out; the protrusion, after cooling, was marked off with an oval line and broken off along this line, finally the broken-off edge was melted round."

Fick repeated the word "protrusion," thus emphasizing that only the protrusion was used. He was still making lenses without a scleral flange. He then continues:

"Such an obviously still rather imperfect bowl was placed by Professor Gaule, in whose Institute I conducted my investigation, in the conjunctival sac of my left eye, and I wore it for two hours without any other subjective complaint but some lacrimation, of course not over the cheeks but only into the nose. A moderate injection was observed objectively, which was stronger at the beginning of the experiment than towards the end and disappeared extremely rapidly after the removal of the glass. The liquid between the cornea and the glass remained perfectly clear. . . ."

He makes it clear that he himself initially wore a simple lens

produced by cutting off a blown glass protrusion. Then he introduces a new and different concept:

"Other people, too, were now ready for the experiment, and since the subsequent experiments were even more favorable than the first with regards to the subjective and objective disturbances and since it was determined that the contact spectacle adheres to the eyeball and thus retains the liquid extremely well and follows all movements of the eyeball without other movements on its own except some occasional rotations around the longitudinal axis of the eyeball, I decided to prepare the contact spectacle in an optically usable form; that means to have it ground. Unfortunately, all prerequisites were lacking here in Zurich, and I contacted via letter Professor Abbe in Jena, asking him to have some contact spectacles made for me. He was good enough to satisfy my request. The specification which so far was found most satisfactory for the preparation of contact lenses reads as follows:

" 'A glass cornea of 8 mm. radius of curvature sits with a base of 7 mm. radius (14 mm. across) on the glass sclera; the latter is 3 mm. wide and corresponds to a sphere with a radius of curvature of 15 mm.; the glass cornea has parallel walls, ground and polished on the in- and out-sides; similarly, the free edge of the glass sclera is also ground and polished; weight of the contact lens, approximately 0.5 g.' "

Here Fick gives a clear description of a scleral contact lens. It occurs in his article in quotation marks, indicating that he was using the specifications of someone else, perhaps Abbe. It is worth noting that the compound lens described here cannot be the same as the simple segments of spherical glass bubbles described earlier. Fick's statement of preference for the scleral lenses, which were secured from Jena and which Fick says were ground and polished,* serves to emphasize the difference between these lenses of compound construction and the earlier lenses cut from round glass bubbles, or from a glass protrusion, blown in Zurich. The difference between his early and later lenses is diagrammed in Figure 4.

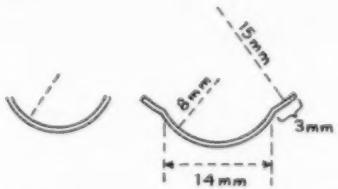


Fig. 4. Left, early Fick lens, (blown and cut in Zurich). Right, later and preferred Fick lens (obtained in Jena).

It is not difficult to see why Fick preferred lenses with scleral flanges, once he had access to them. We know from simple physics that the addition of these flanges provides better support and distribution of the lens weight than can be achieved with simple corneal-type lenses. Weight was always an essential detriment to corneal lenses so long as there was only glass from which to make them.

*In a later paper[5] Fick says that he learned, subsequent to the writing quoted here, that "the glasses from Jena were not ground but only very well blown."

Friedrich Müller of Wiesbaden, writing at the University of Marburg in 1920,[6] recorded the dimensions of some of Fick's corneal lenses:

"Completely new ways for the correction of refractive anomalies of the cornea were undertaken by A. E. Fick in the year 1888. He eliminated the optically useless cornea from the dioptric system and substituted for it a spheric-anastigmatic glass cornea—contact spectacle—which is directly placed upon the cornea and is held fast on the same by adhesion and capillary attraction of the tear fluid in all motions of the eyeball. This idea of A. E. Fick's, to replace the conical cornea by a new one made out of glass, has with time become fundamental for the correction of keratoconus. The contact spectacle consists of a thin sphere of glass of about 8 mm. radius of curvature with parallel surfaces and a basal diameter equal to that of a natural cornea."

The above leaves no doubt that Fick's sphere segments were not larger than a cornea, were placed directly upon the cornea, and were true corneal lenses. Thus the writings of Fick and Müller establish without question that Fick was the first inventor of corneal contact lenses.*

Müller emphasized the distinction between Fick's corneal lenses and the scleral lenses obtained from Abbe by noting:

"From Professor Abbe in Jena, A. E. Fick received, at his request, contact spectacles provided with a narrow scleral part, which were reduced to the following specification:" (Müller then quotes, word for word, the same description of a scleral lens which Fick quoted on page 285 of his article and which is tentatively ascribed to Abbe. This passage has already appeared above.)

Perhaps the first man to work with contact lenses in the United States was Donald O'Rourke. He, too, knew about Fick's early corneal lenses, for in 1928 he described them to the Academy of Ophthalmology and Otolaryngology in these words:

"The contact glass for the optical correction of keratoconus was devised by Fick in 1888. . . . The glass . . . was properly called a contact glass, in the strict sense of the term, because the thin shell of clear glass was placed on the corneal surface with only a thin film of fluid intervening. In its peripheral portion, this glass rested on the peripheral portion of the cornea."[8]

O'Rourke then emphasized the distinction between Fick's corneal lenses and the broad-flange scleral lenses of a later day by stating:

"The first contact glasses which were subjected to prolonged clinical uses, and which aroused widespread theoretic and clinical investigation, were made by Müller of Wiesbaden. The Müller device was made of blown glass. It consisted of a thin shell resembling an ordinary prosthesis. This was an improvement over the Fick glass, in that a flange was added which was designed to fit the sclera. The flange formed a base which supported the corneal segment and raised it from direct contact with the cornea. This improvement enabled the glass to be worn comfortably."

KALT

On March 20, 1888, P. Panas presented to the Academie de Medecine in Paris a report concerning a lens devised by E. Kalt. The report was published in the Bulletin of the Academie.[9] The most pertinent passages state:

"The method which Mr. Kalt presents (for correcting conical cornea) has the

*Fick may also, of course, be regarded as the inventor of scleral contact lenses[7] and the originator of the term "contact spectacle" (Contactbrille).

advantage of correcting the cornea immediately, through suppression of the cone and correction of the anomaly of refraction. It consists of the use of glass shells, similar to those which are sometimes employed in the treatment of symblepharon. These glasses, the size of enamel shells which serve for ocular prostheses, have a radius of curvature similar to that of the cornea. They are well borne for several hours by this membrane, and the feeble irritation which these provoke subsides quickly after their removal. They follow the motions of the eye and adhere nicely to the bulb thanks to the atmospheric pressure. The cornea, being very thinned, conforms exactly to the concavity and finds itself, from so doing, straightened out. If the curvature of the glass is correctly chosen, one can bring about a state of emmetropia and, what is the important thing, the vision is improved over the whole extent of the visual field.

"A patient who could hardly count fingers shown to him at 50 cm. distance, saw his vision improved immediately in this way, so that he could read at a 5 M. distance letters of 26 mm. height. He could also read then a newspaper.

"Thus the optical correction is brought about in a manner quite satisfactory. The future only will show to what degree the effect is curative. These results, obtained in the Poor People's Clinic on two patients, said M. Panas, were ready to be published when a paper by Dr. Fick was brought to our attention, which appeared in the Archiv fur Augenheilkunde, the copy of March, 1888. The author, who has employed a similar method, has arrived at absolutely the same results as far as keratoconus is concerned."

Ocular prostheses of a size sometimes employed in the treatment of symblepharon are smaller than regular prostheses, else there would have been no occasion to mention this special condition. As others will show more specifically in the following paragraphs, Kalt, like Fick, used corneal lenses. However, unlike some of Fick's corneal lenses, Kalt's pressed against the conus, instead of arching over the center of the cornea. Since Kalt fitted his lenses flatter than the corneas, a capillary layer of tears accumulated in and near the contact zone. Consequently no fluid —other than the natural tears—was required.

In 1893 M. A. Chevallereau reported as follows a discussion at the Society of Ophthalmology of France:[10]

Mr. Abadie: ". . . to better his condition (keratoconus), I recommended the patient to wear . . . the contact lenses recommended by Mr. Sulzer. He is very satisfied with them."

Mr. Kalt: "I will allow myself to remind Mr. Abadie that the optical treatment of keratoconus has been simultaneously recommended by Mr. Fick, in Switzerland, and by myself in France about 1887, through a communication to the Academy of Medicine, and not by Mr. Sulzer."

Mr. Sulzer: "The idea of applying lenses to the cornea is much older than Mr. Kalt thinks. It dates from the past century. But the practical realization of the idea has encountered great difficulties. The lenses used by Mr. Fick gave insufficient optical results because of the irregularity of their surface, and Mr. Kalt's lenses, because they lacked a scleral flange, adhered too little to the eye to be useful."

Mr. Kalt: "Mr. Sulzer says that my shells adhered insufficiently to the cornea, and did not lie close. Mr. Sulzer does not seem to take into account that adherence is obtained by atmospheric pressure, just as it happens for two wet glass plates. . . ."

Victor Much wrote in 1932:[11]

"Fick with his first publications on contact lenses . . .. forestalled the almost simultaneous independent experiments of Kalt and August Müller. . . . Kalt, whose experiences were reported by Panas in March, 1888, to the Academie de Medecine de Paris, used ground contact lenses without scleral rims for the correction of keratoconus. . . ."

In 1937 Emile Haas wrote in the Bulletin of the Societe d'Ophtalmologie de Paris:[12]

"After his first experiments,* and to have, as he says a 'better transparency,' Mr. Kalt asked an optical glass manufacturer to construct for him 'thin cut crystal glasses, built according to the curvature of the normal cornea as measured with Javal's ophthalmometer and checked on a casting of corpse's eye.' Thanks to Mr. Kalt, I had the possibility to examine the plaster cast and also three of the glasses that were delivered to him. These glasses consisted of corneal parts only, segments of spheres, whose diameters at the base were 11, 11.5 and 13 mm., respectively. Examined with the two faces in air, they have convergent effects of approximately 1.5, 1.5 and 2 diopters, respectively. Their polish is satisfactory, their refraction very regular. Examined in Javal's ophthalmometer all three show an anterior face free of astigmatism and a radius of curvature of 7.9 mm. Evidently they were ground, probably all three by means of the same ball and the same basin. The difference in their power must be due to the slightly different thicknesses. Mr. Kalt did not tell me which optician had made them.

"It is evident that they must have held—if they held—only by atmospheric pressure, since their diameter is precisely of the order of magnitude of the palpebral opening. The difficulties of their removal, which were indicated by Mr. Kalt, are thus explained, as are also the difficulties of their insertion. It is probable that one and the other might have been greatly facilitated by pneumatic suction."

In the above, Haas recorded explicitly the principal specifications of certain early corneal lenses. It is worth noting that lenses to these same specifications came into common use when corneal lenses were later re-introduced in plastic. Kalt had arrived at modern corneal lenses even while he had only a heavy, poorly suited material from which to make them.

Joseph Pascal of New York City wrote in 1941:[13]

"There was one other worker who is sometimes mentioned as having pioneered independently in contact lens work at about the same time. This was an optician, E. Kalt, who ground some small contact lenses for keratoconus. His lenses just covered the cornea, apparently had no scleral flange, and were designed not only to improve vision, but also to exert pressure against the eye and thus reduce the corneal protrusion. Some of his work was reported by Dr. Abadie in 1893."

In 1942, Theodore Obrig of New York published in his book "Contact Lenses,"[14] the following paragraph:

"E. Kalt—About the same time that August Müller (1889) was experimenting with contact lenses, an optician, E. Kalt, independently carried on an investigation of his own. He ground some small lenses to correct keratoconus which had no scleral band, and rested at the edge of the cornea. They were designed to exert some pressure on the apex of the conus in an attempt to reduce the ectasia as well as to correct the visual error. As might be expected, they were unsuccessful."

In 1946, W. G. Kett stated before the Association for the Advancement of Science of Australia:

"E. Kalt seems to have confined himself to the problem of keratoconus, for which he produced lenses without scleral bands and which exerted pressure on the apex of the cornea.[15]

Thus we find from early ophthalmic literature that Fick and Kalt, the two independent inventors of adhering contact lenses, both began their work with simple corneal lenses. Fick finally preferred narrow-flange scleral lenses; Kalt went on to procure carefully ground

*A communication from R. A. Dudragne of Paris, who knew Kalt, states that Kalt's first experiments were made with segments cut from the bottom of test tubes.

and polished corneal lenses which would be indistinguishable from many corneals worn today, except that they were made of glass.

ORIGIN OF THE TERM CORNEAL LENS

The first use of the term corneal lens appears in the year 1889. In his doctoral dissertation, written in that year, August Müller employs the word "Hornhautlinsen" (corneal lenses).[16]

ZEISS

In the course of improving the form of spectacle lenses, leading technicians at the Carl Zeiss Optical Works in Jena made themselves artificially far-sighted, near-sighted, and astigmatic with corneal lenses. In this way they could better test the effectivity of the new types of spectacle lenses on which they were at work. These men wrote:

"In the year 1912, M. v. Rohr and W. Stock suggested that the contact lenses which consisted of only one corneal part be used, not for the correction of visual errors but, on the contrary, by means of them to bring about to a determined extent visual errors (simple faulty vision and astigmatism). With this means an expert could actually test various visual aids, the effects of which would otherwise be difficult to determine."[17]

One of these lenses reposes in the Deutsches Museum of Munich. A photograph of it is shown as Figure 5.

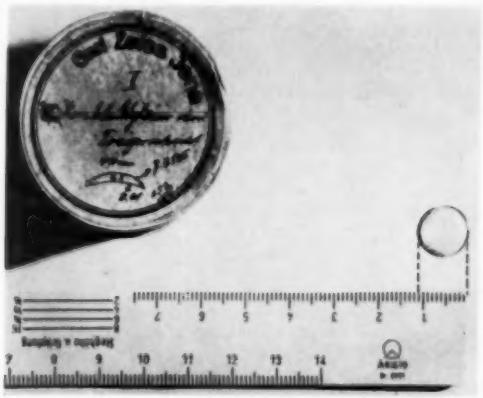


Fig. 5. Photograph of early corneal lens made by Zeiss. This lens is now in the Deutsches Museum, Munich, Germany; there identified as one of the lenses used by Stock in his experiments.

Von Rohr and Stock also contributed the following reference to corneal lenses:

"First the right eye of M. von Rohr (Ametropia = —6.4 D.) by application of a Fick-type contact lens was made emmetropic. Because of the difficulty of manufacturing, we limited ourselves in our experiments to the optically effective part of the contact lens, the glass cornea, in Fick's manner of expression. We proceeded with the application in such a manner that the observer, sitting on a chair, by horizontal position of his head, the fitted eye after administration of cocain drops, pointed directly downward, while he pulled down his lower lid. Following, the contact lens was filled

with physiological sodium chloride solution and pressed from below upwards on to the cornea of the vertically downward looking eye. It adhered well right away most of the time, that is, without air bubbles, and it only needed minor movement to produce a central placement. The lid blinking moved the glass sometimes a little, so that in the first experiments the appearance of astigmatism could not always be avoided."[18]

Then and subsequently, Zeiss produced corneal lenses. Von Rohr, in his "Textbook on Eyeglasses" wrote:

"Contact lenses without scleral portion have been manufactured already in 1912 by Carl Zeiss, Jena. Amongst others, Professor Doctor H. Erggelet has worn those special contact lenses. By them he made himself artificially ametropic and in this way tested the optical quality of corrected curve eyeglasses."[19]

In 1923 von Rohr again wrote on the same subject:

"Dr. H. Erggelet, who has emmetropic eyes of a high acuity and enjoys perfect stereoscopic vision, made one of his eyes temporarily hypermetropic, requiring a correcting glass of D = 13 diopters. He used a contact glass for this purpose and was able to wear it for some time, from 25 to 30 minutes. In 1913 we could make these contact glasses in a primitive form only, so that the movement of the eye-lid sometimes dislodged the contact glass. However, to form a general impression these old contact glasses answered well enough."[20]

Several years later, and for a different purpose, the Zeiss Company produced corneal lenses. In 1932, in an article titled "Therapy in Treating Detachment of the Retina," H. J. M. Weve of Utrecht wrote:

"Ophthalmoscopic examination is greatly facilitated by placing on the cornea a small corneal contact lens made by Zeiss. . . . this lens also serves well in meridian determination . . ., since by means of it, the so-called meridian error as a result of astigmatism is avoided."[21]

In 1932 a published report by H. J. M. Weve contained the statement:

"During localization of retinal tears, ophthalmoscopy is aided by the use of a small corneal contact lens of Zeiss. This prevents drying, fogging and reduces corneal astigmatism."[22]

In the same year Weve also wrote:

". . . while the patient is still on the operating table, an examination with the ophthalmoscope takes place. At this stage we found it convenient to place upon the cornea a contact glass 11 mm. in diameter and of a 7½ mm. radius of curvature, which for this purpose had been prepared by the Zeiss Company at our request. The troublesome drying out of the cornea is thereby prevented, and a thorough ophthalmoscopic examination can be performed immediately after the operation."[23]

Ida Mann stated in her history of contact lenses:

"Weve used small contact lenses without a scleral portion. . . ."[24]

Prior to World War II, glass corneal lenses were sold by the Carl Zeiss Company in the United States. Although the supply of these lenses was cut off by the war, some of them are still in existence. One is shown in Figure 6, photographed beside a typical plastic corneal lens, made in the United States following World War II, after transparent plastics became available.

GUALDI

Vincenzo Gualdi, of the University Eye Clinic in Florence, Italy, wrote in 1934 an article titled: "New Corneal Contact Lenses for Correcting All Ametropias."[25] In it he said:

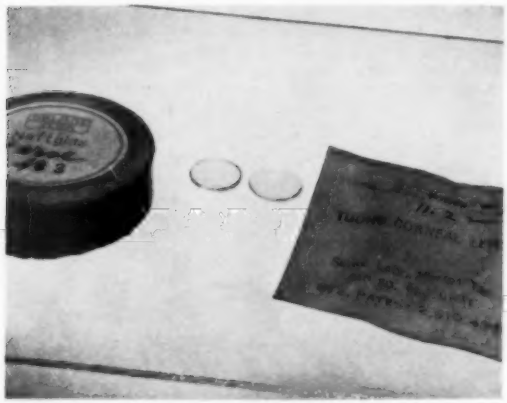


Fig. 6. At left center a glass corneal lens made by Zeiss, photographed beside a plastic counterpart, right center, which is in use today.

SPECIFICATIONS

	Zeiss Lens (1932)	Solex Lens (1948)
Inside radius	7.5 mm.	7.5 mm.
Overall size	10.9 mm.	11.2 mm.
Center thickness	.6 mm.	.3 mm.
Power in air	+0.25 D.	—1.50 D.
Material	glass	plastic

"From the very beginning I had rejected the manufacture of . . . lenses with two curvatures, namely for sclera and cornea. . . . I therefore preferred to construct the lenses with a single inner curvature. Because this curvature is always less than the curvature of the cornea, there is the advantage that a liquid lens of the type of a divergent meniscus can always form and thus prevent the formation of air bubbles.

"Six types were produced: 10.5; 11.0; 11.5; 12.0; 12.5, and 13 mm. radius. Our corneal lenses are made of crown glass. They . . . have a diameter of about 20 mm., weigh .5 g. and are about .5 mm. thick.

"The final lens is well borne by the sclera.

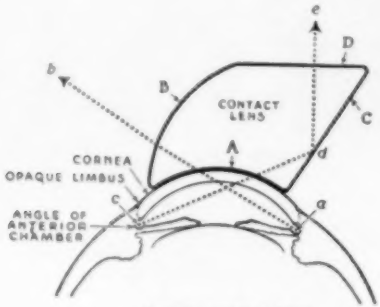
"The new contact lenses are manufactured by 'Officina Scientifico-Meccanica A. Frusoni,' manufacturing opticians, Piazza S. Maria Maggiore, Florence, Italy."

Gualdi provides an example of a corneal type of lens made so large that, by strict definition, it is no longer a corneal lens, since it is "borne by the sclera." Nevertheless, his work is of interest in passing, if only because of his use of the term "corneal glasses" ("vetri corneali"), and his specifying that the curvature of his lenses is always less than the curvature of the cornea.

ALLEN

In 1944 Lee Allen of the State University of Iowa described a new plastic contact lens for gonioscopy.[26] It is thick, so as to provide the required lens and prism effects, and sometimes requires external support like the early corneal lens of Descartes. Allen wrote:

"The concave contact surface A (Figure 7), of the lens has a diameter of 10 mm. and a radius of curvature of 7.86 mm. Since the outer surface of the average cornea has a radius of curvature of 7.84 mm., a capillary film of tears forms between the lens and cornea when the two are in apposition. This film creates optical continuity between the contact lens and cornea and also serves to hold them together."



A new contact lens.

Fig. 7. (From *Science*, March 3, 1944.)

Here is a lens with a special purpose (observation of the angle of the anterior chamber), not for correction of vision. Nevertheless, here again appears the concept of a refractive lens, slightly flatter than the cornea, and resting upon the cornea, entirely within the limbus of the eye.

Nineteen of the above references to corneal lenses, all published in ophthalmic literature between 1888 and 1946, show that this type of lens came into existence very early in the development of contact lenses.* Early corneals were used to correct ocular errors: to induce ocular errors: to improve observation of the interior of the eye and to prevent drying of the cornea. We find corneal-type lenses which extend beyond the limbal zone (Gualdi) and others which lie within it (Fick, Kalt, Zeiss). These latter were the true early corneals. There were corneal lenses more curved than the cornea (Fick) and others less curved (Kalt, Gualdi, Allen). Yet always, before the invention of transparent plastics, they could only be made of glass and were consequently heavier, more fragile and often less smooth than plastic** and for these reasons did not enjoy the commercial success of plastic corneal lenses. Since corneal lenses must cling to the front of the cornea without support other than

*References 4, 6, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 20, 21, 22, 23, 24, and 26 all describe or refer to true corneal lenses.

**It is difficult to grind glass corneal lenses with sufficiently smooth interior surfaces. When they are blown instead of ground, it is difficult to produce good optical surfaces to specific power.

capillary adhesion, weight and irregular surfaces were serious impediments to their wide use so long as there was only glass from which to make them. Consequently, although invented prior to scleral contact lenses, they were largely supplanted by sclerals.

The writer of the present report wrote in 1948 in an article which described plastic corneal lenses:

"Full credit for the development of the corneal lenses is acknowledged to Kevin M. Tuohy. . . ."[27]

This statement was inserted into the article so that no one could assume that the writer was taking credit for the development of the lenses he was presenting. Nevertheless, the statement would not have been left in its unqualified form had the writer then been aware of all the prior work on corneal lenses which has since come to his attention. It is important not to ignore earlier contributors to a science. In deference to them, and to the facts, the above statement is herewith retracted.

When corneal lenses were revived in plastic, at least two men, Kronfeld and Rakos, are known to have pointed out publicly that corneals were not new.*

PLASTIC CORNEAL LENSES

The development of transparent plastics† led to renewed interest in corneal lenses. In these plastics, lens makers have new optical media which are more workable than glass. They may turn plastics on a lathe instead of grinding them. They may quickly finish them to a high polish. Also, they can safely make them thinner than fragile glass lenses. Reduced thickness results in less weight, and also in reduced lid irritation. But of even greater significance in corneal lens use is the fact that optical plastic has less than half the weight of glass.** The specific gravity of the plastic used is 1.12: of glass, 2.52.

In 1937 John Mullen and Theodore Obrig greatly increased the degree of success obtained with scleral contacts by making their lenses from the newly available clear plastic, instead of glass. However, the weight of glass is a far more serious detriment to corneal lenses than it

*Peter Kronfeld, in the discussion which followed the reading of Maurice Nugent's second report on corneal lenses,[28] stated: ". . . eighteen or twenty years ago, we used in our retinal detachment work a forerunner of this lens to keep the cornea clear. . . . it was made of glass and obtained from Zeiss." Emerich Rakos wrote an article[29] mentioning many early experiments with glass corneal lenses, several of which are also mentioned in this paper.

†Rigid methyl methacrylate is the plastic used predominantly in contact lens manufacture. Its first known commercial use in the United States was on aircraft in 1936 (Rohm and Haas, Research Department communication).

**"The corneal lens is manufactured from the acrylic resin, methyl methacrylate. . . . It is light in weight (one-third as heavy as glass)." Kevin M. Tuohy in "Corneal Lens Fitting," published by Solex Laboratories, 1950.

is to sclerals. Kevin Tuohy observed the increased success which his employer, Obrig, obtained with plastic sclerals. In 1948, in his own venture, Tuohy began the manufacture of corneal contact lenses, making them also of plastic.

The basic principle and structure of the earlier glass corneal lenses were excellent. However, they had three disadvantages extending from the use of glass: (1) the psychological factor of placing a piece of breakable material in the eye; (2) the weight of the earlier glass corneal lenses, which was more than twice that of present day plastic corneal lenses (and even plastic corneal lenses are none too light); and (3) glass corneal lenses are difficult to produce with a smooth inner surface. With the reintroduction of corneal lenses in plastic all of these disadvantages were done away with. There was an upsurge in the use of these lenses.

Plastic corneal lenses, at the time of their commercial introduction, were made in sizes from 10.8 mm. overall to 12.5 mm. The radii ranged from 7.20 mm. to 8.95 mm. With the usual bevel around the periphery of the ocular side, they weighed as little as .05 gram. They appeared when the war-induced demand for scleral lenses was declining, and made possible a revival of interest in contact lenses. They provided better appearance and greater average success in performance than the plastic scleral lenses which preceded them.

MICRO-CORNEALS

In Germany, in 1952, Wilhelm Sohnges began to use a diminutive lens with less than half the bulk of the earlier corneal lenses.[30] After refinement by himself and his collaborators, John Neill and Frank Dickinson (who, each in his own country, had begun similar experiments), the diminutive lenses are now made about twice as flat, with respect to the corneas on which they rest, as the earlier plastic corneal lenses.* The smaller lenses are micro-corneal contact lenses, frequently referred to as microlenses.** They are usually made without a bevel, and are essentially a small Kalt-type lens, made of plastic. The diminished size and thickness and the wider departure from the corneal curve, all permit a greater increase in tear circulation to the cornea than that obtained with earlier plastic corneals. As a consequence the earlier and larger type was largely superseded by microlenses, with gratifying improvement in performance in most instances.

CONFORMING MICRO-CORNEALS

Another concept in corneal lenses has rapidly gained ground. It is

*Early corneals were .1 to .2 mm. flatter than the cornea. Micros may be as much as .6 mm. flatter or more.

**This name, now in wide use, was suggested by Mrs. Frank Dickinson.

embodied in lenses which superficially resemble the first microcorneals. However, instead of being much flatter than the corneas on which they rest, they conform very closely to the corneal contours at their optical center.[31]

By approximating the inside curve of the lens to that of the cornea, central corneal contact becomes quite uniform, instead of being concentrated in localized areas, as with most of the earlier plastic corneals. The newer lenses do away with much of the corneal flattening which causes "spectacle blur" (blurred vision through spectacles due to temporary corneal deformation). Essentially, they conform to the apical portion of the cornea instead of deforming it.

The average size of corneal lenses having a conforming optical center portion is slightly smaller than that of earlier micros, and the newer lenses are slightly thinner. With the passage of time the average size fitted tends to diminish further. The lenses are often more comfortable and serviceable than any other type of corneal lens.

A summary of various corneal lens dimensions is given in Table 1.

TABLE 1.
Known Dimensions of Various Corneal Lenses

			GLASS		
Fick (1888)	radius	8	mm.	overall size:	that of natural cornea (10 to 13.5 mm. ±)
Kalt (1888)	"	7.9	mm.	" "	11, 11.5, 13 mm.
Zeiss (1932)	"	7.5	mm.	" "	11 mm.
			PLASTIC		
Early Plastic Corneals (1948)				" "	11 to 13 mm.
Micro-Corneals (1952)				" "	9 to 10 mm.
Conforming Corneals (1956)				" "	7 to 9.4 or more mm.

Conforming corneals, while a definite advance in many respects, are still far from perfect, and so the effort toward further improvement continues. Today we find in use, at least experimentally, minute lenses which are more curved than all meridians of the cornea (a complete reversion to Fick's early approach to fitting, except that they are not so curved as to require accessory fluid). We find also truncated corneal lenses, shaped like a tiny Univis R segment. These thin, pillow-shaped scales cover little of the cornea except the central optical area directly over the pupil. There are also lenses with elevating facets; with indentations to augment tear circulation; with concentric rings of corneal contact. There are tiny corneal lenses with toroidal back surfaces, to conform all the more closely to toroidal corneas.[32] There are corneal

lenses with a multiplicity of minute perforations. There are others in which the central zone of the ocular surface is recessed slightly so as to clear the corneal apex. There are also, and quite significantly, corneals which are constructed to conform to the corneal apex and clear most of the periphery of the cornea.[33] New developments such as these, together with other experimentation which is going on, make it reasonable to expect that in this year of 1958 the evolution of adherent corneal lenses, begun in 1888, is still far from finished.

SUMMARY

The published literature on corneal lenses shows that they were first invented by A. E. Fick and described by him in 1888. In the same year Panas of Paris announced Kalt's corneal lenses. The specifications of some of Kalts lenses are known precisely. They are identical to many corneal lenses currently in use, except that they were made of glass.

In the twentieth century transparent plastics were developed which are light in weight and practically unbreakable. With these it became possible to make lenses thinner and much lighter than glass equivalents. Corneal lenses were then reintroduced, some of them in forms and sizes indistinguishable from Kalt's. Since that time smaller lenses and newer concepts of fitting have come into wide use.

ACKNOWLEDGMENTS. The location of references on the evolution of corneal lenses has called for the generous cooperation of many people throughout the world. Chief among these are:

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Viktor Much	Tel-Aviv
Donald O'Rourke	Denver
Henry Oster	Los Angeles
Philip Salvatori	New York City
Wilhelm Sohnges	Munich
W. M. Van Sciver	Chicago
Grace Weiner	Los Angeles
The Carl Zeiss Company	Oberkirchen

To all of these I am deeply grateful. I am equally grateful to the many others who contributed less voluminously, but no less willingly, to this work. The assistance of the Medical Center Library in Washington, D. C., the Crerar Library of Chicago and the Bio-Medical Library of the University of California at Los Angeles is also acknowledged.

The writer would appreciate receiving any further information on corneal lenses which might augment what has been set forth here.

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ANNOUNCEMENT

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A completely new 1100-page third edition of the well-known I.E.S. Lighting Handbook, to be published in March, 1959, has been announced by the Illuminating Engineering Society, international lighting organization.

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A PRELIMINARY REPORT ON THE INCIDENCE OI ESOPHORIA AMONG MENTALLY DISTURBED PATIENTS*

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Probably the most comprehensive definition of the phoria reflex would be a combination of that of Duke-Elder[1] ". . . the condition wherein the eyes in their conjugate movements are maintained on the fixation point only under stress with the aid of corrective fusion reflexes" and that of Krimsky[2] "The phoria response means the status or position which either eye assumes when its impulse to binocular fixation is removed as by covering an eye or breaking fusion through some ocular means." This reflex was first mentioned by Donders[3] in 1864. The heterophorias were described and named 22 years later by Stevens.[4] In 1889, Maddox[5] began establishing the concepts which have become the foundation for present day thinking on the nature of the phenomenon. Stevens,[6] in 1906, agreed with the theory that "binocular fixation is normally accomplished by the three elements of tonic, accommodative and fusional convergence," and pointed out the significance of the phoria measure, noting that ". . . an esophoria should be regarded with suspicion and be submitted to further examination." Sheard,[7, 8] in 1917, reaffirmed the nature of the convergence effort and three years later established 5Δ to 6Δ of exophoria as being the physiologic norm at the near point level. This finding was confirmed, in 1925, by Weymouth, Brust and Gobar.[9] Haines[10] and Shepard,[11] in 1941, and Morgan,[12] in 1944, established 1Δ of exophoria as the normal expected finding for distance.

Shortly after the beginning of World War II, the writer noted an increasing incidence of esophoria in his patients which could not be accounted for by either refractive error or other somatic disorder. It occurred at either the near point or distance level or at both, in individuals who were being subjected to severe mental stresses. Although these patients came with complaints of asthenopia the symptoms failed to yield to either corrective lenses or orthoptic treatment. However, release from the psychic stresses by such things as in employment or relief from worries, brought immediate remission of the symptoms.

In 1941, Peter,[13] in discussing the etiology of esophoria, said "It

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is a condition of overaction, especially overaction in a highly neurotic type of individual. In fact, if one were asked to name the second great factor in esophoria, the answer, unhesitatingly, would be a "highly strung nervous system."

In 1949, Duke-Elder[1] agreed, describing among the etiological factors ". . . disturbances affecting the lower neurons, anomalous or irregular excitations of the lower centers, disturbances of the proprioceptive connections of the oculomotor apparatus; but the majority of cases, not accommodative in origin are due to increased innervations the nature of which is problematical.

"A large group is thus an expression of central overactivity finding an outlet through convergence impulses and, for this reason, is typically seen in the energetic or unrestrained—in the young, strong and sthenic or the neurotic type of individual. In such cases the central imbalance may be associated with endocrine overactivity and is typically overaccentuated by work, stimulants (tea, coffee, tobacco) and the excitements and anxieties of a busy life in conditions of high tension. Unfortunately, a considerable number of cases are neurotes exhibiting a very irregular esophoria, the degree of which varies from day to day with the temperamental condition; it is these in which the symptoms are most prominent and most difficult to combat."

Despite these challenging statements there appears to have been no study of them undertaken within the ophthalmic professions. In 1943, Strongin and Bull,[14] psychologists at Columbia University, reported on 13 normal and 15 psychiatric subjects. They came to the conclusion that the lateral phorias are in a constant state of flux and thus wholly unreliable when taken at a single sitting. However, examination of their technique in making the phoria tests reveals two gross errors. A Maddox rod and Risley prism were used. The subject was required to align the streak and the light by manipulating the prism while the examiner was waving a 6 x 9 card before the phorometer. Anyone who has attempted to take his own phorias knows how elusive alignment can be, even to a trained observer. With the additional handicap of a constant interruption of vision it is a tribute to the patience of Strongin and Bull[14] that any readings were achieved. There are no fewer than five acceptable techniques for making phoria tests. In 1948, Hirsch and Bing[15] studied the comparative values of the five most commonly used techniques and found "the most striking single conclusion is perhaps the high reliability of all the phoria tests."

It was, therefore, decided to make a study of the incidence of esophoria among a group of psychiatric patients at Hillside Hospital

and to compare these findings with those in a group of non-hospitalized subjects who were functioning in an apparently normal manner, without complaint.

The test group consisted of 115 in-patients and 51 out-patients. Patients were selected only as to availability at the time the tests were being made. Patients deemed insufficiently organized to respond properly, strabismics and malingerers were excluded. A skiascopic examination was made prior to testing. Testing was done with correction. There were 38 men and 87 women, a true reflection of the population of the sexes at the Hospital. There was a high incidence of schizophrenics, also typical of the population of the Hospital, at that time. The target for distance consisted of a 3-inch strip of ¾-inch adhesive tape set vertically on a dark wall, at eye-height. The target for near was a small cross on a white card set at 13 inches. An AO phorometer with 30Δ Risley prisms, and the Von Graefe technique for testing were used. A 6Δ plano lens was placed before the right eye, base-down, the Risley prism before the left. After eliciting an acknowledgment of diplopia, the Risley prism was turned to a position of high base-in and then reduced to alignment. This was repeated from a position of high base-out. If the two findings coincided, this figure was recorded. If the two findings did not coincide, the test was repeated several times. Where there was a discrepancy of 1Δ the mean finding was recorded. When the discrepancy exceeded this amount, the two extreme findings were recorded. The same procedure was then repeated at 13 inches.

The control group consisted of Hospital Staff whose cooperation had been enlisted. They ranged from laborers to professional personnel. No medical or optometric personnel was used. The same criteria for screening was used as in the test group. There were 26 men and 94 women.

Subjects were divided into esophores and exophores. This was done on the basis of the following reasoning. In 1951, Tait,[16] in using the Von Graefe technique on 4,880 patients, reported an experimental error of 0.5Δ due to faulty judgment of the individual patient and an additional error, in the same degree, due to faulty reading of the calibrations on the Risley prisms. Morgan,[17] in 1956, in a study of 88 patients reported an error of approximately 1.5Δ. Morgan's figure was arbitrarily chosen and an additional 0.5Δ was added for bias. Since the established norms for lateral phorias are 1Δ exophoria for distance and 6Δ exophoria for near, patients exhibiting 1Δ or more of esophoria at distance or 4Δ or less of exophoria for near were classified as esophoric. All others were classified as exophoric. Findings

were grouped according to age and tabulated as in tables 1 and 2. The total number of patients with esophoria and with exophoria in the test group and in the control group were set up in a 2 x 2 Chi square table. The value of χ^2 was approximately 13.0 which for one degree of freedom has a probability of less than 0.001.

TABLE 1
TEST GROUP

AGE	EXOPHORIA	ESOPHORIA	TOTAL	% ESO
20-29	13	28	41	68.3
30-39	23	19	42	45.2
40-49	21	11	32	34.4
50-59	7	3	10	30.0
	64	61	125	48.8

TABLE 2
CONTROL GROUP

AGE	EXOPHORIA	ESOPHORIA	TOTAL	% ESO
20-29	22	15	37	40.5
30-39	34	12	46	26.1
40-49	24	3	27	11.1
50-59	9	1	10	10.0
	89	31	120	25.9

DISCUSSION

Any discussion of the findings of this investigation must be tempered by the limited nature and numbers of the subjects involved. We have made a lateral phoria test, at distance and near, on a group of psychopathic patients most of whom are female schizophrenics. We have compared these findings with those taken from a group of individuals, similar in number and age, who are regularly employed and apparently functioning normally. In each age group, the psychopathic subjects showed a higher incidence of esophoria than was found in the control group. For each age group the difference was found to be at least 20%. A graph of the findings showed marked similarity of the curves for both groups. We know[18] that even though there is no rigid association of accommodation and convergence a change in accommodation will always produce a change in convergence, as evidenced by the phoria findings, whereas the converse is not true. It can, therefore, be concluded that:

1. There is evidence that there is a significantly higher incidence of esophoria in the mentally disturbed than in the "normal" population.
2. This higher incidence of esophoria appears to be caused by disturbance of the function of accommodation.

The results raise more questions than they answer. While these results are of significance to the ophthalmic professions, psychiatry, neurology and psychology should also have a great interest in some of these new questions. Further study is most certainly indicated.

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EYE MOVEMENTS AND THE AUTOKINETIC ILLUSION*

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INTRODUCTION

Although a century and a half have passed since the autokinetic illusion was first reported, the nature of the phenomenon is still far from clear. According to Adams,[1] it was discovered in the year 1799 by Humbolt, an astronomer. He noticed that, after watching a very faint star for a short time, it would suddenly start to move around in various directions. He thought that the star actually *did* move, and this phenomenon was observed by astronomers for years, and was considered as an actual movement of the star. It remained for Schweiser, in the middle of the 19th century, to prove that it was an illusion. This was done simply by asking several persons to watch the same star for a period of time: it was found that they all reported different directions of movement.

The same illusion may be observed by watching a small, dim light in an otherwise dark room: after one watches the light for a short period of time, it suddenly starts to move. The movement is so realistic that if naive observers are used, it is sometimes very difficult to convince them afterwards that the light was actually stationary.

A considerable amount of research on the subject has been conducted in the past half century, following the groundwork laid by Carr[2] and Adams.[1] In view of the fact that the different investigators have obtained some conflicting results, and therefore have formulated several different theories to account for the illusion, it may be profitable to review the experimental evidence that has been obtained to date, and to compare and evaluate the theories which have been proposed.

EXPERIMENTAL EVIDENCE

EXPERIMENTAL CONDITIONS

As might be expected, the autokinetic illusion has been studied under a large variety of experimental conditions. As to the stimulus object itself, it is usually in the form of a pinpoint of light, approximately one millimeter in diameter. It is usually composed of white light, although a few investigators have used red light. In some cases

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very large stimulus objects have been used, as large as five centimeters square. In other cases, even rectangular and cross-shaped objects have been used.

It is pretty well agreed that the general illumination has to be at such a level that nothing in the room except the stimulus object can be discerned. However, there is evidence that an experienced observer is able to obtain the illusion even if the objects in the room are dimly illuminated.

Distances from a few feet to twenty feet have been used. The most frequently used distance, however, seems to be in the neighborhood of a meter or two. In most of the investigations, the stimulus object has been in the straight-ahead position. However, some experimenters have used stimulus objects oriented at various angles from the straight ahead position.

Confinement of the head is found to vary from no confinement at all, to the use of a head rest and biting bar.

Some of the experiments were performed under conditions of monocular vision, some under conditions of binocular vision, and some under both conditions. In addition, some investigators did not specify whether monocular or binocular vision was used.

Another important experimental variable concerns the kind and amount of instruction given to the subject, and the degree to which the subject is naive or sophisticated. These matters become especially important when it is realized that the autokinetic illusion is highly subject to suggestion.

It will be helpful to bear in mind the above differences in experimental conditions, when considering the results obtained by the different investigators, and also when considering the theories which have been propounded, based on these results. It is quite possible that the differences in experimental conditions may account for some of the differences in the results and consequently for the differences in theory also.

DIRECTION, EXTENT, AND SPEED OF MOVEMENT

The movement can apparently take place in any and all directions. Adams[1] reports that the favored direction of movement depends upon the amount of strain on the eye muscles in the various directions. Other experimenters have reported that some individuals seem to observe movements more in one direction than in another. As to the extent of movement, many authors do not state the movement in terms of degrees, but rather in terms of drawings made by the subjects, by means of which only relative amounts of movement may be ascertained. How-

ever, Cogan[3] states that the spot may appear to wander 20 or more degrees, and Carr[2] reports that one subject reported movement of 65 degrees under conditions of marked eye fatigue and constrained eye position. Carr also reports a maximum velocity of 15 or 20 degrees per second, under conditions of constrained eye position.

There is evidence that the extent of movement is dependent upon the dimensions of the room as remembered by the subject. For example, the light was not likely to move below the level of the floor, and if it did, it seemed to then travel along the floor toward the subject. Concerning motion in the third dimension, Edridge-Green[4] observed that the light came close enough so that he felt he could touch it, even though he knew it was twenty feet away.

Adams found that the character of the movement was determined by the shape of the light.[1] He found that when a round light was used, motion was generally in an arc of a circle, often spinning like a billiard ball; when a square light was used, motion was usually angular rather than arc-like; and when a rectangular light was used, fastest motion was in the direction of the long axis.

ROLE OF SUGGESTIBILITY AND VOLITION

An interesting experiment was performed by Hoffman, *et al.*,[5] concerning the role of suggestibility. In the first part of the experiment the subject was asked to observe an actually *moving* light, moving either 2" within a 6" illiminated lucite frame, or moving 8" within a 14" lucite frame, and was asked to report the extent of the movement. The average movements reported were 2.99" and 8.55," respectively. In the second part of the experiment, the subject was asked to observe a *stationary* light, without the lucite ring, and was not told that the light would not actually move. Subjects reported average movements of 3.89" and 7.57", which shows that norms for autokinetic movement can be pre-determined by proper exposure.

Carr[2] reported that by thinking of and attending to some object in the periphery, all observers could get movement in that direction; also, a sudden and unexpected sound often deflected the light in its direction.

Crutchfield and Edwards[6] did an experiment in which the subject was given ten "trials" in which the stimulus for autokinetic movement was attended to, then was told to fixate a semi-circular figure for 140 seconds, and was then given ten more "trials." In each case, the duration of each trial was 2.14 seconds. They found a big decrease in the amount of movement after fixation of the figure.

Haggard and Babin[7] investigated the roll of reinforcement in the

autokinetic illusion. They employed motor reinforcement, in which the subject drew an arrow on a piece of paper, either in the same direction or that opposite to the direction relative to that of the illusion, and also reward reinforcement. They found that motor reinforcement in which the arrow was drawn in the *same* direction as that of the movement of the illusion to be most effective, and reward reinforcement to be least effective.

EFFECT OF POSITION OF THE EYE IN THE ORBIT

Employing a headrest and biting bar, Adams[1] presented the stimulus in 33 different positions: the straight-ahead position, and at 10, 20, 30, and 40 degrees from the straight-ahead position in each of eight different meridians. He found that the direction of the illusory movement tended to be the same as that in which the eye was turned, and indeed for the extreme positions the correlation was almost 100 per cent. This he attributed to strain on eye muscles.

EFFECT OF IMMOBILIZATION

Goldman[8] had his subjects observe the illusion under each of three conditions: immobilization, free situation, and mobility. In the condition of immobilization, the subject was strapped to a chair which prevented movement of the legs, trunk, and head, and was kept in it for ten minutes prior to the presentation of the stimulus. In the free situation, the subject was not strapped, but sat quietly. In the condition of mobility, the subject was required to move both arms continually in a prescribed manner.

He found that, the greater the degree of motor involvement, the longer the time of appearance of the illusion, the shorter the duration of the first phase, and the less complex the pattern of movement.

TYPES OF MOVEMENT OBSERVED

Carr[2] reports the following types of autokinetic movement, which were observed by his subjects:

1. Point of fixation remains with light in movement.
2. Point of fixation is steady, light moving away from it.
3. A combination of the above types of movement.

In the discussion of his results, however, he refers mainly to the first type of movement. Also, it seems significant that Adams,[1] who worked in Carr's laboratory and carried on experiments which were a continuation of Carr's work, does not mention the three types of movement. None of the other investigators reported movement of the three types discussed by Carr.

CORRELATION WITH EYE MOVEMENTS

In what was possibly one of the first attempts to observe eye

movements during the observation of the illusion. Carr[2] employed a grating made of threads in order to observe the movement of the cornea, using a dim flashlight which did not disturb the illusion. He found no eye movements in what he referred to as the first type of movement (in which the point of fixation moves with the light) but he found movements of the cornea of from three to four millimeters in extent in the second type of movement (in which the point of fixation remains steady and the light moves away), the eyes moving in a direction opposite to that of the reported movement of the stimulus.

In addition, Carr quotes an experiment of Bourdon, in which the room was suddenly illuminated by an assistant while the subject fixated the light: the eye was found to be fixating the light in the first type of movement, and fixating in a secondary position in the second type. Bourdon also found that, if, after the light had moved, he turned his eyes back to what he thought was the original fixation point and illuminated the room, his eyes were found to be directed away from the fixation point by the amount of the voluntary rotation. These observations tend to show that, at least in the first type of movement, eye movements are not involved in producing the illusion. In regard to the second type of movement which Carr refers to, it may be considered that if a person "sees" this type of movement, it is because he is *trying* to maintain what he *thinks* is steady fixation: thus when the light is turned on, he finds that he is not fixating the light. Actually he knew all along that he wasn't actually fixating the light, or why would he report that the fixation point was held steady but the light moves away? In other words, whether the subject reports type 1 or type 2 movement depends upon the subject's *reaction* to the movement, not upon the movement itself.

It should be added that all of the four observers used in Carr's experiment were aware of the nature of the phenomenon, and it might be postulated that they were trying to *resist* the illusory movement, knowing as they did that the spot did not actually move. Therefore, if one used naive subjects and let them think (as Hoffman did) that the light was *actually* moving, it is doubtful that any of them would report Carr's type 2 movement, as they would have no reason to try to resist the movement of the light by trying to hold steady fixation. If the above assumption is true, it will be more profitable to concentrate on the type 1 movement and realize how the type 2 movement relates to it.

In 1928 Guilford and Dallanback[9] studied eye movements during the autokinetic illusion, using a Dodge eye movement camera

which they modified by substituting a moving film for the falling plate. They used as a stimulus object a red spot 2.5 cm. in diameter at a distance of 1.7 meters from the subject. Their records showed no gross eye movements during the illusion, although tremors were recorded.

Skolnick[10] in 1940, photographed the eye movements in the horizontal direction during the observation of the illusion, using the ophthalmograph. The light source caused a glare in the lower half of the field, but not enough to interfere with the illusion. Twenty-five records were taken on twenty-one subjects. Nine records showed nystagmus with the fast phase in the same direction as that of the eye movement. Fourteen were questionable, showing considerable eye movements but no nystagmus, and two showed very little eye movement.

Skolnick also observed the corneal reflex directly, on the focusing screen of the ophthalmograph. He describes the procedure as follows: "when movement of the corneal reflection indicated nystagmus or large involuntary drifts of the eye, he (the experimenter) called out the probable direction of the illusion. The subject then responded with the actual direction." Eight possible directions were considered (such as up and to the right, etc.) and of a total of 790 "calls," 60.6 per cent were correct, 15 per cent were half correct, and the remainder incorrect. In view of the fact that it has been shown pretty conclusively that the illusion is subject to suggestion, this type of evidence would have to be accepted only with much reservation.

However, Skolnick realized the possible effect of suggestion, and performed another series of experiments in which the experimenter did his recording in writing, rather than verbally. Out of 220 calls, 38.6 per cent were correct, 33 per cent were half correct, and the remainder incorrect. Since there are a total of nine possibilities (including no movement), Skolnick states that a chance score would be 11 per cent. This is not quite true, since the "no movement" category is present: if the eyes did not move at all during the illusion, the experimenter would have a very good chance of being 100 per cent correct. Skolnick does not give the number of "no movements" present in the series. Also, it must be remembered that, as cited above, most people tend to have the movement mainly in certain directions: it would therefore be quite easy for the experimenter to *unconsciously* pick the direction in which he knows the movement is most apt to occur for the individual subject, thus reducing the number of possible directions by one-half or more. It may be mentioned in passing that Gordon Walls has used Skolnick's results in formulating a theory of visual direction.

Cogan[3] uses the autokinetic illusion as evidence that there is no

proprioceptive afferent system in the extra-ocular muscles. Quoting: "Indeed, while the observer may think his eyes are fixed, the light may appear to wander 20 or more degrees eccentrically, owing to the involuntary eye movements. Lacking a proprioceptive sense, the subject is unaware of the fact that his eyes are moving."

THEORIES OF THE AUTOKINETIC ILLUSION

Adams, in his 1912 paper, discussed all of the types of theories which have since been referred to in attempting to account for the autokinetic illusion. These are:

1. The "streaming" theories.
2. Eye movement theories.
3. The "strain" theory.

THE STREAMING THEORIES

Guilford[11] and Guilford and Dallanbach[9] reported that their subjects saw the light moving behind a veil of some opaque material. This appearance may be likened to the appearance of the moon behind moving clouds: it is easy to imagine that the moon is moving, and that the clouds are standing still. They assumed that the moving veil was due to "streaming" caused by chemical materials in the retina. Guilford and Dallanbach hypothesize the streaming theory to account for the fact that they found no eye movements during observation of the autokinetic illusion. Guilford believes that the streams responsible for the apparent movement involve the whole retina at once, and he further states that, since the moving disc leaves behind it a trail of light gray or a hue complimentary to that of the moving spot, this may be taken to mean that the retinal streams are washing chemically altered material away from the region of stimulation.

Edridge-Green[4] proposed the following explanation to account for the illusion: "The currents seen are currents caused by the liquid sensitized by the visual purple flowing into the external fovea. When there is visual purple in the fovea this is the most sensitive part of the whole retina, but when there is none there time must elapse before it can diffuse onto the spot." Feree,[12] reporting in 1908, advanced the theory that the phenomenon was caused by streaming over the retina of some material which is capable of directly affecting the processes that condition visual sensation.

Other proponents of the streaming theory believe that the streaming is a cortical process rather than being a retinal process. Haggard and Babin,[7] for example, liken the streaming to the alpha rythm, and feel that this is evidence that the streaming is cortical in nature. They also feel that it is analogous to the scotomas of migraine, and point out

that migraine scotomas are the same for both eyes. In addition, they feel that the fact that they found the streaming to be subject to voluntary control lends further support to the cortical theory. Crutchfield and Edwards[6] also feel that a central process is involved, but instead of adhering to the streaming theory, they cite the satiation theory of Kohler and Wallich as a possible explanation. They base their decision on the fact that a subject can observe the optokinetic-producing stimulus with one eye, then observe the fixation target with the other eye, and will still get a reduction in the autokinetic movement after fixation.

EYE MOVEMENT THEORIES

The work of Skolnick[10] in which he attempted to correlate the direction of movement of the stimulus to the direction of movement of the eye, has already been discussed. In addition, Skolnick performed experiments involving eye movements of the nystagmus type. For example, in one experiment he rotated his subjects to the left before observation of the stimulus: all nine subjects that were used reported that the spot moved to the right under such conditions. He also stimulated the ear with cold water, and found movement in the opposite direction. He concluded from these experiments that the illusion *can be* due to eye movements of an involuntary nature.

THE STRAIN THEORY

Chief proponents of the strain theory are Carr[2] and Adams.[1] Carr, as mentioned above, found that when the stimulus was placed in such a position that the eye had to turn within the orbit in order to see it, movement of the illusion tended to be in the same direction in which the eye was turned. Carr postulated the following theory to account for his results, in the type 1 movement:

> "The only possible basal term of reference is the space feeling of the body as reported by the kinasthetic and organic sensations and the tactual experience due to contact with objects in the room. In these conditions of perception, the object of the foveal activity stands in constant space relation to the eye. This fact was demonstrated by the tests on eye movement. Consequently the eyes are the only possible means of connection between the visual object and bodily space. The eyes, tactually and kinesthetically considered, are a part of the bodily space. A correct definition of the position of the visual object relative to the body thus depends upon a correct appreciation of eye-body relation. Any visual conditions of eye-body relation must result in an erroneous sense of the position of the fixated light in reference to the body."

He uses this theory to account for the fact that the illusion is under voluntary control. Again quoting:

> "Introspective observations indicated that the innervation or strain sensations of certain ocular and facial muscles are necessary and essential to voluntary control: that mere volition . . . is functionless . . . In voluntarily deflecting the movement to the right, there was a rightward ocular strain which often became painfully fatiguing."

Adams also adheres to the strain theory, postulating that the fatigued muscle will be more strongly innervated—i.e., more impulses

will be sent to the higher centers from that muscle which has previously been associated with eye movement in a *given direction*. Since fixation remains with the light, the subject will think the light has moved in the direction in which the strain is exerted, producing the illusion of a pursuit movement.

He refers to another experiment in which the strength of the eye muscles was ascertained by using prisms, and the strength of the muscles was found to correlate with the preferred direction of movement. He does not say, however, what kind of testing was done with the prisms. Guilford,[11] as a check against the results of Adams, had the divergence, convergence, and sursumvergence of three subjects tested by an optometrist, and found that the amounts of vergence did not show any relation to the direction of movement. It is rather difficult to compare these two experiments, since the vergences measured by Guilford's optometrist were disjunctive movements, while the type of movements used by Carr and Adams to produce the strain were conjugate movements.

Concerning the matter of suggestion, Adams says: "suggestion was effective because of a tendency to move the eyes in the suggested direction without actually doing so. Therefore, strain would be put upon the muscles moving the eye in that direction, which would result in movement in that direction."

As further evidence favoring his theory, Adams refers to the case of a person with paralysis of the right external rectus muscle: objects move toward the right when the patient tries to look to the right. His explanation is that "data which have meant movement in the past are present, and are interpreted to mean movement."

SUMMARY AND CONCLUSIONS

Even though some of it may be open to question, the evidence cited above for each of the three theories is convincing enough to make it seem rather foolish for one to dogmatically reject any one of them. In fact, observation of a pinpoint of light in a dark room for a period of time gives one the impression that with so little to "hold on to," most any stimulus could cause one to "let go." Such stimuli could be chemical or electrical excitation in the retina, pathway, or cortex; innervation of the extraocular muscles; small involuntary eye movements; sounds (particularly if localized as coming from a given direction); sensory and proprioceptive impulses from the muscles of the neck, trunk, and legs, and so forth. It would probably be desirable, therefore, for future investigators to make an attempt to seek out all of the factors which may be responsible for producing the autokinetic illusion, rather than to try to prove or to disprove a particular theory.

As to the streaming theory, one method of approach would be to do experiments under complete dark adaptation, to rule out any retinal phenomena which may serve as a "film" for streaming (particularly after-images and other effects commonly seen just after closing the eyes). The question of streaming being retinal or cortical in nature could easily be attacked by dissociating the two eyes, as with rotary prisms, and ascertaining whether or not the "streams" of opaque material are the same for the two eyes.

Many different approaches may be taken in order to evaluate the role of eye movements in producing the illusion. For example, photographic records of the same subject and with the same recording instrument under both illusion-producing conditions and conditions of steady fixation of an object in an illuminated room should help in evaluating the effect of small, involuntary eye movements. Experiments done under monocular conditions with the stimulus object at a distance of twenty feet or more, would rule out stimuli to accommodation, convergence, and fusional movements as possible unknown variables.

In order to further evaluate the strain theory, more experimental work should be done with the stimulus object in different positions (with the eyes in different positions relative to the head). Control experiments with the head allowed to "point" in the direction of the stimulus object would also be of value, in order to rule out the effect of suggestion (in this case the eyes would always be in the straight-ahead position as they relate to the head).

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OPTOMETRY IN PUBLIC HEALTH PROBLEMS*

Optometry was represented by several committees at the annual meeting of the American Public Health Association, October 27-31 in St. Louis. Dr. Felix Koetting, A.O.A. chairman on Social and Health Care Trends, started arrangements about a year ago to have as many committees represented from the American Optometric Association as possible. In addition to his committee, the Motorist's Vision and Highway Committee was represented by Dr. Robert Sneller of Hastings, Nebraska, and the Committee on Vision Care of the Aging was represented by Dr. Ralph E. Wick, of Rapid City, South Dakota. The scope of this meeting must be seen to appreciate the attendance of approximately 3,000 people interested in the field of Public Health. Items of interest to optometry were discussed in the School Health Section, the

*By Ralph E. Wick, O.D., chairman, American Optometric Association Committee on Vision Care of the Aging. Excerpts from a report "Optometry Represented at the American Public Health Association Annual Meeting." Submitted on December 10, 1958, for publication in the February, 1959, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

Public Nursing Section, The Medical Care Section, and one paper of unusual interest was discussed in the Epidemiology Section.

Another paper of direct interest to optometry was presented by Heirik L. Blum, M.D., M.P.H., on an "Investigation to Design and Evaluate a Vision Screening Program for Elementary School Children." One of the principle co-authors of this paper who was acknowledged by Dr. Blum was Henry Peters, M.A., O.D., associate clinical professor of optometry at the University of California. This was an especially well prepared piece of research which demonstrated the successful operation of ophthalmology, optometry, and Public Health officials working together in a given community for the benefit of all concerned. Clinical examinations were done separately by optometrists at the University of California, School of Optometry and ophthalmologists at Stanford University, School of Medicine. Over a thousand students were checked by optometrists and ophthalmologists for a longitudinal study to cover a three year period and different screening procedures were compared with one another against the clinical examination. Several recommendations were made as a result of this study:

1. A steering committee with representatives from education, ophthalmology, optometry, public health and parents groups should develop the program. The committee, through its professional members, must obtain acceptance of the program and screening criteria by the professional persons in the community.

2. The examiner doing Modified Clinical Technique wherever used should have a certificate of completion from an accredited school of optometry, or a M.D. degree with one year of specialized training in ophthalmology in an accredited training center, or two years of practical work in ophthalmology.

3. The professional modified clinical technique examiner should act as an employee of the agency responsible for the school health program, and even if part time, should not be in private practice anywhere in the region so that the economic interest of the examiner cannot become an issue.

4. Children who have had the modified clinical technique once, and who passed, should be tested annually thereafter with the Snellen test. Teacher observation should be done constantly. The Snellen testing and the reports of teacher observation, where feasible, should be completed prior to the annual visit of the modified clinical technique professional examiner. In this way, children failing the Snellen or referred by teacher observation could be screened by the modified clinical

technique at the same time as the first graders are being examined, and before being referred for private professional attention.

5. The parents of those children with known visual problems in grades two and above should receive a reminder of the need for regular professional attention once a year. It is fair to say that children with visual problems change more and require the most frequent vision attention.

6. The school health education program should include formalized work on visual health. It should also impinge on the parents so that there will be family interest in getting regular professional attention for children with vision problems.

The modified clinical technique recommended for the professional examiners consists of the visual acuity test, the cover test, the skiametry, inspection for organic problems with both a hand magnifier and ophthalmoscope. The results of this investigation established beyond any question what has been felt by most professionals in the field of vision care for many years, namely: that a professional doing a modified brief clinical technique actually estimating the degree of defect involved resulted in the finest possible type of visual screening procedure.

Another section of indirect interest to optometry was the Medical Care Section on Wednesday afternoon with a panel discussing the subject of "Financing Medical Care for the Aged." This was a well run panel with the problems stated by Franz Goldmann, M.D. His paper consisted of a review of the large number of people involved and what the role of the government might have to be in the care of the aging population. The Public Welfare View Point was stated by Mary S. Weaver. The Viewpoint of Organized Medicine was stated by Henry A. Holle, M.D., who is on the committeee for the Care of the Aging of the American Medical Association. Voluntary Health Insurance Viewpoint was stated by J. F. Follmann, Jr. The Hospitals' Viewpoint was stated by James P. Dixon, Jr., M.D. The panel was mainly concerned with the major types of illnesses and chronic diseases. Little direct mention was made of either dentistry or optometry in this discussion. It was obvious, however, that the establishing of a long range viewpoint in the financing of medical care for the aged would eventually include all of the professions related to health care.

A program of special interest to optometrists was presented on Thursday morning by the National Society for the Prevention of Blindness. This again was a well conducted panel which contained reports mainly of large mass scale screenings by the use of the Snellen chart. It was felt by members present that optometry would have a

real contribution to make in this area. It is hoped that optometrists in general will work closer with their local affiliates of the National Society for the Prevention of Blindness to assist in the proper organization of these screening programs.

The paper on "Medical Aspects of Reading Failures in Intelligent School Children" by George E. Park, M.D., was a comprehensive study of a large number of cases of dyslexia. Dr. Park is the attending ophthalmologist of the Dyslexia Memorial Institute of Chicago. Every type of medical test which could logically be used on these non-readers was employed. They consisted of various blood tests, brain wave studies, metabolism tests, complete vision tests including muscle analysis and fusion studies, etc. It was found that only 19 per cent of these children had visual defects. This was near enough the statistical average for normal children that it was not considered significant. The problem is not solved and much experimental work is to come. No one simple cause can be found although some significant causes were starting to manifest themselves as a result of the study. The paper was presented informally and will probably be published in its entirety in the SIGHT SAVING REVIEW. The main point at present is that a complete physical, mental as well as visual study must be made of all these children if we are to give them the best care.

All in all the attendance at this national meeting of the many disciplines devoted to public health care was most stimulating. Optometry has for too many years talked largely to itself. This is an opportunity to talk to many leaders in the field of Public Health work. Organized optometry must be represented at meetings of this type. Individual participation in these activities should be encouraged and the official participation by the American Optometric Association must be continued from year to year in order to assure its effectiveness.

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CURRENT COMMENTS

Terry Judith Parkins
Editorial Assistant

Optometrists will confer a favor by sending news items of general interest for this department; such as relate to new instruments, clinical techniques, education, visual health and optometric legislation and organization.

TURVILLE ON QUEEN'S NEW YEAR HONORS LIST

According to the A.O.P. News* Mr. A. E. Turville, described as "lately ophthalmic optician to the Birmingham University Health Centre," is among the names appearing in the New Year Honors List. Despite the description given, Mr. Turville will perhaps be better known to optometrists the world over in another context.

During his long and very full career as an ophthalmic optician Mr. Turville has been on the General Council of the A.O.P. and was elected as president for six years. He has been a member of the Council of the British Optical Association and of the Joint Emergency Committee where he was chairman for six years, when ill-health caused his retirement. He was a chairman of the Institute of Ophthalmic Opticians and served on the Council of the Joint Council of Qualified Opticians, when these bodies were in existence.

In the international field he has represented Britain on the Executive of the International Optical League and was elected to the presidency of the British Chapter of the American Academy of Optometry in 1953. He is also a Fellow of the Distinguished Service Foundation of Optometry (U.S.A.) and an honorary member of German and Danish optical associations.

He is a Liveryman of the Worshipful Company of Spectacle Makers and the Ernest Aves Medallist for 1954. In 1957 he was awarded the B.O.A. Research Medal for his outstanding work in ophthalmic optics.

As an educationist his most valuable contribution has been the organization of the examinations of the Scottish Association of Opticians. He has been the Adviser on Education and Examinations to the S.A.O. since 1936. He is also a B.O.A. examiner.

Writing in the BRITISH JOURNAL OF PHYSIOLOGICAL OPTICS in June, 1933, he mentioned an "unequal latency of refractive errors as between the two eyes." This was apparently the first reference ever made to what is now usually termed "uniocular difference in latency." This led to much of the work Mr. Turville has done which included, amongst other things, the Esdaile-Turville equilibrium test, the Tur-

*Journal of the Association of Optical Practitioners. Issue January 8, 1959, page 7. (London.)

ville infinity balance, the Turville comprehensive unit and quite recently a new infinity balance unit and near diagnostic unit.

Other matters that are closely connected with him are the Turville-Stewart ophthalmoscope, the Turville-Pascal dynascope, and the Turville-Pascal photoscope.

PREPAID OPTOMETRIC CARE IN CANADA

The first national privately sponsored plan for prepaid optometric care was announced by the Canadian Association of Optometrists during January, 1959. The plan will operate on a non-profit basis through the newly organized Canadian Optometric Services, Inc., 32 Front St. West, Toronto 1, Ontario.

The Canadian Association of Optometrists has organized this new public service to provide comprehensive vision care at reasonable cost to organized groups or associations of Canadians from coast to coast. Under this new program two basic plans are available to enable vision care to be prepaid. These two plans are further adaptable to fit the specific needs of industry or groups of individuals. Under one plan Canadian Optometric Services pays the total cost of usual optometric services, including frames and lenses. Under the second plan the same coverage is provided except that the subscriber pays a small sum each time he requires professional attention. Premiums under the second plan are naturally lower. The program is flexable in that it may be added as an additional benefit to existing health and welfare plans.

The cost of the plans will vary, depending on their type and extent of coverage, but a basic plan providing complete examining and refractive services and ophthalmic materials will be between 65 - 80c per month per person, or as little as $1.95 to $2.10 per month for a family. The exact price will depend on such things as the occupation of the subscriber (i.e., some occupations are more demanding on the eyes than others), the age groups involved and so on.

The Canadian Optometric Services program will cover the usual services supplied by an optometrist. At present the Canadian Association of Optometrists estimate that one-third of the population is not seeing as well as it should and this new program is devised to make services of optometrists available to a larger number of patients than heretofore.

With the establishment of this new service, Canadian optometrists move ahead of the optometrists in the United States. Only in California are similar plans available and these are, to a large degree, servicing only certain union groups. Optometrists everywhere will watch this new development with much interest.

LUMINOSITY FUNCTIONS OF ALBINOS

The Indiana Chapter of the American Academy of Optometry contributed $225 to the Indiana University Division of Optometry in support of a preliminary study of the luminosity functions of albinos. The research will be done by Professor Ingeborg Schmidt. This is the third in a series of grants made by the Indiana Chapter in support of special research studies.

Dr. Schmidt has collected the names and addresses of a number of albino patients who have been examined in the Optometry Clinic and plans to enlist their cooperation as subjects. Their spectral luminosity responses will be determined by flicker photometry and compared to normals. This information should help determine the extent to which the structure of the central retinal region of albinos differs from that of normals.

EYES ON COMMUNICATION BY BLICKLE & PASSE

An outstanding article on technical writing has just appeared in Vol. XXIV, No. 3, 1958 of THE O-EYE-O, published by Beta of Epsilon Psi Epsilon at the Ohio State University. The Publishing address is 58 East 12th St., Columbus, Ohio.

This paper is entitled *Eyes and Communication* and is written by Margaret Blickle, Ph.D. and Martha Passe, Ph.D. of the faculty of the University. Both teach technical writing in the English Department and their paper is full of good suggestions to be followed in planning and writing technical papers. This article should be read by all optometrists as it is a valued contribution to our literature.

Dr. Glenn A. Fry, director of the School of Optometry, The Ohio State University, says that some extra copies of this issue of THE O-EYE-O are available and will be sent without cost to optometrists who request a copy.

NEWS BRIEFS

The 62nd annual American Optometric Association Congress will be held in Dallas, Texas, June 28 through July 1, 1959. Dr. Arthur Harris of Dallas will be general convention chairman. . . . The Benson Optical Company is building a new home office and laboratory building at 18th and Park Avenue in Minneapolis. . . . The Southwestern Contact Lens Congress will be held at the Hotel Roosevelt, Waco, Texas, on March 21-23. Guest speakers will be Dr. John C. Neill, Philadelphia; Dr. Bernard Mazow, Houston, and Dr. Robert Graham, Pasadena. . . . Bausch & Lomb has announced a new plastic Vernier Magnifier that enlarges scale lines for greater ease in reading. . . .

The Saskatchewan Optometric Association held its 50th anniversary February 15-19 in Regina. . . . Dr. George L. Brown, Paulsboro, New Jersey, has been named chairman of the New Jersey Chapter, American Academy of Optometry. . . . The American Optical Company has introduced a new men's cataract frame designed to minimize the appearance of high-powered lenses. . . . Dr. Louis Jaques, Los Angeles, will be the speaker at the Oregon Optometric Convention in Medford, May 15-17. . . . Liberty Optical's new heavyweight frame for men, the Spokesman #520, will have coast-to-coast distribution early in March. . . . The 4th annual Eastern Seaboard Conference on Visual Training will be held in Washington, D. C., Shoreham Hotel on May 20-21. Dr. Robert A. Kraskin will be chairman. . . . The design of the new Shuron Rococo spectacle case is an embossed gold in a simulated Florentine pattern on imported vinyl. This is available on either a blue or brown base.

The Optometric Center of New York has been granted a Charter by the Board of Regents of the University of the State of New York. . . . The Illinois College of Optometry has been notified that funds have been allotted to the College as the Federal Capital Contribution for the establishment of a National Defense Loan Fund under title II of Public Law 85-864 which is known as the National Defense Education Act. These funds are for student loans which are repayable over a 10 year period after graduation. . . . The annual post-graduate courses for optometrists at the Ohio State University School of Optometry will be given the week of June 15-19, 1959, on the campus at Columbus. . . . Dr. Melvin D. Wolfberg, Selinsgrove, Pennsylvania, has been elected alumni member of the Board of Trustees of the Pennsylvania State College of Optometry. . . . Mr. E. B. Higgins, Managing Director of the Canadian Association of Optometrists, writes that their Childrens Vision Committee has produced a 32 page manual entitled *Childrens Vision Manual* which contains the detailed procedure for conducting a screening program in schools, including an outline of the techniques involved, the equipment required, with a review of the public relations aspects of screening. This material will be sent to optometrists. The cost is $5.25 and orders should be sent to 32 Front Street West, Toronto 1, Canada.

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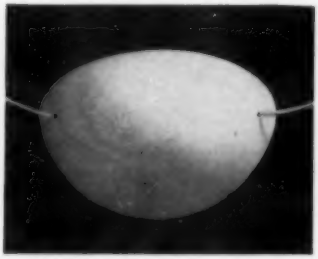

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